

REMARKS

Applicants wish to thank the Examiner for her diligent examination of this application. Please reconsider the application in view of the following remarks.

Status of the claims

Claims 19-21 were previously canceled without prejudice. Currently, Claims 9-18 are pending in the application. Claims 9, 10, and 18 are independent. Claims 11 – 17 depend, directly or indirectly, from Claim 10. No amendments are made to the claims in this Reply.

Interview Summary

A telephone interview was conducted on July 25, 2008 between Examiner Chacko-Davis and Applicants, during which Applicants discussed with the Examiner the relevance of the prior art and the merits of the pending claims. No agreement was reached between Applicants and the Examiner.

Rejections under 35 U.S.C. § 103:

Claims 9-18 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over (U.S. Patent No. 6,143,116 ("Hayashi") in view of U.S. Patent No. 6,159,322 ("Ogata"). Applicants respectfully traverse this rejection as follows.

With regard to independent Claim 9, the claim recites:

A method of producing a multi-layer circuit board by preparing a circuit-parts sheet which comprises a photo-cured ceramic sheet and a circuit-forming pattern through the steps (a) to (e) described below and, then, conducting the steps (f) to (h) described below:

(a) forming the circuit-forming pattern having light-nontransmitting property on a surface of a carrier film having light-transmitting property;

(b) forming a photo-curable ceramic coating layer having a thickness not smaller than the thickness of said circuit-forming pattern and in which said circuit-forming pattern is buried, by applying a photo-curable slurry containing an electrically insulating ceramic material on the surface of the carrier film on which said circuit-forming pattern is formed;

(c) forming a photo-cured ceramic sheet by photo-curing said photo-curable ceramic coating layer which is not present on the circuit-forming pattern by the irradiation with light from the back surface of said carrier film, wherein the photo-curable ceramic coating layer which is present on the circuit-forming pattern is not photo-cured;

(d) removing uncured portions of said photo-curable ceramic coating layer by using a developing solution;

(e) peeling off said carrier film;

(f) preparing a plurality of pieces of the circuit-parts sheets obtained through the steps (a) to (e);

(g) laminating a plurality of pieces of the circuit-parts sheets;
and

(h) firing the laminate thereof.

As an initial matter, Applicant believes that the Office's Response to Arguments set forth in this instant Office Action misconstrues the teachings of Hayashi in several ways. Specifically, the Office Action stated that

“Hayashi, in col 15, lines 40-67, and in col 16, lines 1-31, discloses the use of slurry that has an inorganic filler i.e., an electrically insulating material, and that the slurry is a polyimide resin i.e., the slurry is photocurable and is applied on the transfer sheet wherein the transfer sheet has a wiring circuit pattern formed on its surface. The slurry is not selectively applied, it is applied on the entire surface, i.e., on the circuit pattern (wiring pattern) and in the via holes on the transfer sheet, and exposed to light through the back surface of the transfer sheet, i.e., the slurry in the via holes are photocured, whereas the slurry disposed on the wiring pattern is masked from the irradiation and is therefore unexpected i.e., not photocured.”

Applicants note that the text of Hayashi cited in the Office Action (col 15, lines 1 – 67), when read in whole, describes a detailed process for making a conventional transfer sheet.

For example, column 15, lines 44 – 48 states “...a resist of a photocurable resin was formed in the shape of a circuit pattern and was immersed in a solution...” Applicants wish to clarify that what is described here is a conventional method of forming a photoresist mask on a copper foil and developing (etching) the mask to form a circuit. Applicant respectfully points out that the photocurable material is not used in the multi-layer board itself.

Next, column 15, lines 49 – 61 describes preparing an insulating slurry and applying the slurry onto the surface of the insulating board and half-cured by heating at 120°. Applicant notes that this slurry is a thermosetting resin, not a slurry of photocurable material.

Finally, column 15, line 62 – column 16, line 15 describes using a tackifier which loses tackiness upon light radiation on the transfer sheet and irradiating the transfer sheet while peeling it off the board. Applicant notes that the light irradiation described therein is used to de-tackify the transfer sheet, not to cure any photocurable material.

In response to the Office's assertion that Hayashi discloses a method of forming a multi-layered circuit board substantially the same as the claimed invention except for the final step of firing the laminate, and then cited Ogata as teaching the missing step to remedy the defect of Hayashi, Applicants respectfully traverse as follows.

First, with respect to the teachings of Hayashi, the Office Action stated that "Hayashi, in the abstract, in col 2, lines 65 – 67, in col 3, lines 1 – 20, in col 7, lines 60 – 67, in col 8, lines 1 – 59, in col 13, lines 1 – 62, in col 15, lines 1 – 67, in col 16, line 1 – 32, discloses a method of forming a multi-layer circuit board comprising forming a circuit pattern on a transfer sheet (transparent carrier film, the circuit pattern being non-transmitting), forming a slurry of photocurable material (the slurry containing an electrically insulating ceramic material such as an inorganic filler material) on the circuit patterned insulating board, and photocuring the slurry material by irradiation with light via the back side of the transfer sheet, developing the non-cured portions (immersing in solution), adhering the insulating board with the circuit pattern to that of the circuit layer on the transfer sheet (or ceramic green sheet, with through holes filled with conducting paste) and laminating by pressing and heat curing (lamination done such that the transfer sheet and substrate are opposed to each other i.e., the circuitry face each other), repeating the process by preparing multiple insulating boards, in the method described above, with circuit patterns, and adhering the boards with transfer sheets comprising the wiring circuit layer, and laminating the circuit parts together by pressing and heat curing, followed by peeling the transfer sheets (see figures 2(A) through 2(D), and 4(D)) to form the multi-layer circuit laminate." Applicants specifically disagree with the above description of Hayashi's method.

Column 2, line 65 – column 3, line 22 of Hayashi summarizes its method in steps (a) – (e).

In step (a), a first circuit pattern is formed on a first insulating board. Note that this board is to become the outer most layer of the final 3D circuit board. It is not a transfer sheet. The insulating board is made of a thermosetting resin (col. 5, lines 2 – 9), not a photocurable material.

In step (b), via holes are formed in a soft second insulating board containing a thermosetting resin, the holes are then filled with a conducting paste. This thermosetting board is to become inner layers of the final multi-layer circuit board. Again, the second board is also made of a thermosetting resin (col. 7, lines 63 – 67), not a photocurable material.

In step (c), a second circuit pattern is transferred to one side of the second soft insulating board from a transfer sheet by pressing the pattern into the board in a manner that closes the openings on one side of the via holes. Column 9, line 12 – column 10, line 7 describes a conventional method of forming a transfer sheet to be used in this step. Note that once the pattern is press-adhered to the second soft insulating board, the transfer sheet is peeled off (col 10, lines 12 – 13). No slurry of photocurable material is formed or applied to the transfer sheet. No light irradiation to cure the photocurable material took place. No developing the non-cured portions took place.

In step (d), the second insulating board made in step (c) is laminated to the first insulating board with the side that has open via holes facing the circuit pattern side of the first board. At the end of this step, the via holes are sandwiched between the circuit pattern of the first insulating board and the circuit pattern of the second insulating board.

In step (e), more layers are added to the board following steps (b) – (d) to build up the final multi-layer circuit board.

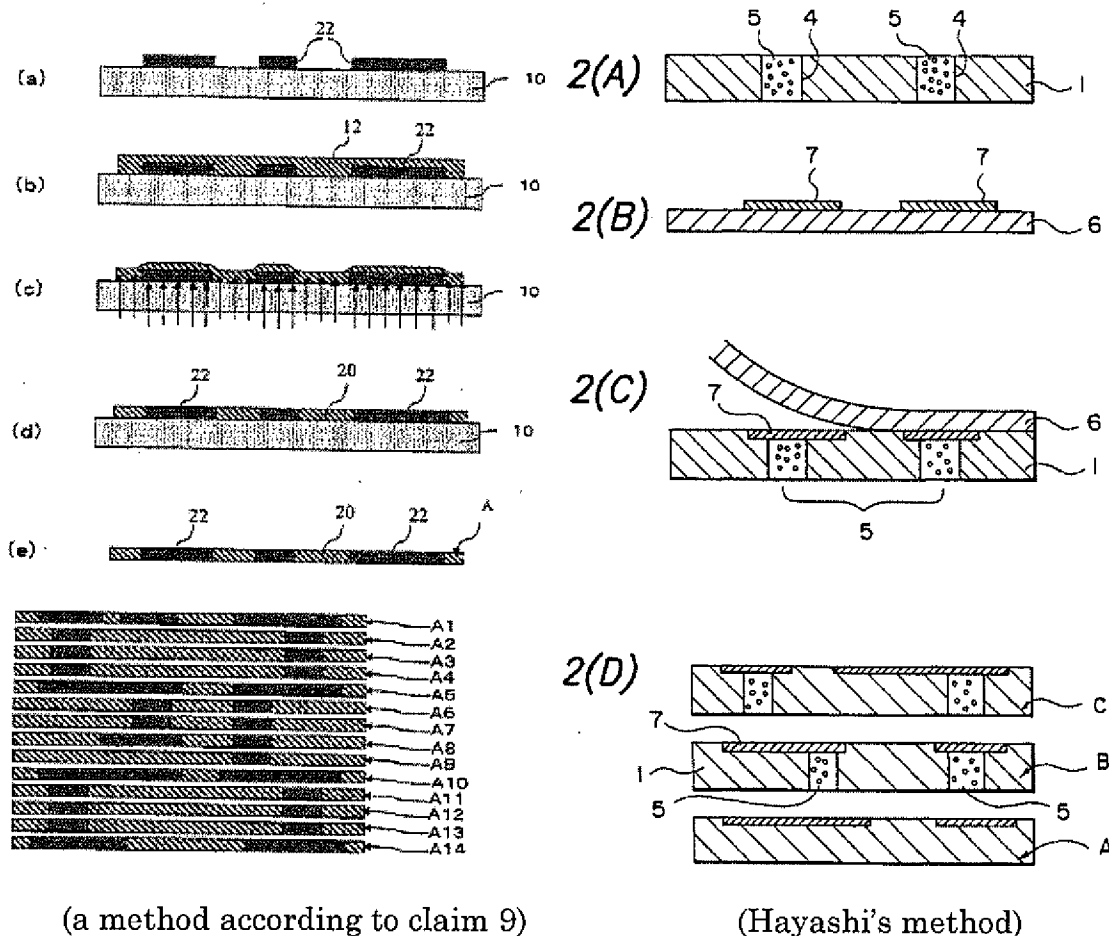
On page 4, lines 3 – 4 of the Office Action, the Office also erred in stating that column 9, lines 24 – 37 and figures 1 and 2(D) of Hayashi teach “...the surface roughness of the insulating board is not smaller than $1\mu\text{m}$ (i.e., surface roughness is not smaller than from 0.3 to $3\mu\text{m}$)”. Referring to Hayashi column 9, starting from line 24, it is stated that “...the metal foil used for forming the conducting layer 7 has an average surface roughness (R_z) of not smaller than $0.1\mu\text{m}$, particularly from 0.3 to $3\mu\text{m}$...” What is taught by Hayashi is the roughness of the metal foil, not the insulating board. In fact, Hayashi is completely silent as to the roughness of the insulating board.

In view of the above, Applicants respectfully submit that the Office has error in its assessment of the teachings of Hayashi and has mistakenly drawn parallels between the method of Hayashi and the method of Claim 9.

Moreover, MPEP §2142 clearly states that in order to establish a case of *prima facie* obviousness, the Office must determine whether the claimed invention “as a whole” would have been obvious at the time of the invention to one of ordinary skill in the art, and avoid impermissible hindsight in reaching a legal conclusion. To this end, Applicants submit that the Office has not considered the claimed invention as a whole in comparison to the teachings of Hayashi.

In the following figures, Applicants show a side-by-side comparison of a method according to Claim 9 and Hayashi’s method. On the left-hand side, figures excerpted from Applicants specification Figures 2 and 3 show in drawings the general method steps in accordance with the present invention. On the right-hand side, figures excerpted from Hayashi’s Figure 2 show the general method steps taught by Hayashi. From these figures, one can see that there are no parallels between the two methods. For example, in the method of Claim 9, step (a) requires forming a circuit pattern on a light transmitting carrier film. In step (b), a photo-curable, non-conducting slurry is poured onto the carrier film to fill the gap between

the circuit patterns. In step (c), the non-conducting photo-curable material in the circuit gaps are cured, while in step (d) the non-cured portion are removed to form a solid sheet of circuit-part sheet. In contrast, the method of Hayashi does not have any of these method steps. Thus, when considered as a whole, the method of Claim 9 does not share any method steps with the method of Hayashi, nor do they operate under the same principles, i.e. they are two completely different methods.



As for Ogata, the reference teaches a photosensitive ceramic green sheet. The Office Action relied on Ogata only for teachings of heating (firing) laminated

ceramic green sheets after lamination. Ogata does not teach or suggest any of the method steps of Claim 9, nor was it relied upon as such.

Having addressed the differences between the teachings of the cited prior art, Applicants now turn to the issue of whether Hayashi and Ogata, either considered alone or combined together, can render the claimed invention obvious. To this regard, the Office Action stated that it would have been obvious for those skilled in the art to arrive at the method of Claim 9 by firing Hayashi's laminated multi-layer circuit board for the reason of enhancing mechanical strength. Applicants submit that this proposed combination cannot render Claim 9 *prima facie* obvious for at least the following reasons.

First, MPEP §2143.01(V) clearly requires that the proposed modification can not render the prior art unsatisfactory for its intended purpose. MPEP §2143.01(VI) also requires that the proposed modification cannot change the principle of operation of a reference. In this instant case, the method of Hayashi is intended to produce a multi-layer circuit board as shown in the above figure. The operating principle of Hayashi's method is to use soft insulating boards having via holes as the base boards for the circuit patterns and then connects the different layers of circuit patterns through via holes filled with a conducting paste. Having the goal and operating principle in mind, it would have been readily apparent to anyone skilled in the art that any attempt to alter the method of Hayashi to match the method of Claim 9 would have violated the operating principle and resulted in a completely different method useless for the purpose of making Hayashi's multi-layer circuit board. Accordingly, there would have been no motivation or suggestion for one of ordinary skill in the art to modify the method of Hayashi in a way that would result in the method of Claim 9.

Second, MPEP 2143.02(II) also requires that in order to combine the teachings of two references, there must be a reasonable expectation of success. In

this instant case, the Office Action proposed firing the multi-layered circuit board of Hayashi as suggested in Ogata for the reason of increasing mechanical strength. This reasoning cannot be supported because Hayashi already teaches a way to increase mechanical strength by including a layer of strong material in the inner layers of its laminate. Hayashi also teaches that differential thermo expansion is a major concern for its multi-layer circuit board (col. 6, lines 50 – 67), signaling that overheating the multi-layered circuit board may not be a desirable thing to do. Further, what Ogata teaches is heating ceramic green sheets at a temperature range of 600 – 1600°C (col 19, lines 19 – 28), but in Hayashi's method, the insulating boards are made of thermosetting resin such as polyethylene ether (PPE) which typically has a curing temperature at around 200°C. The use of thermosetting resin is critical to its method and cannot be replaced, yet Ogata is completely silent with regard to the effect of firing thermosetting resins. Thus, the teachings of Ogata are not relevant to Hayashi. The result of firing Hayashi's multi-layer circuit board in a high temperature furnace, as suggested by the Office, would not have been readily predictable to one of ordinary skill in the art at the time of the invention based on the teachings of the cited prior art or general knowledge in the art. In view of these facts, a person skilled in the art, at the time of the invention, seeking to increase the strength of Hayashi's multi-layered circuit board would not have had any motivation to go outside of the teachings of Hayashi, much less follow the teachings of Ogata.

In summary, Applicants submit that the Office has erred in its determination of the scope and content of the prior art (MPEP §2141(A)) and has erred in its assessment of the differences between the prior art and the claimed invention taken as a whole (MPEP §2141(B)). These errors notwithstanding, Applicants have shown in the above discussion that when considered as a whole, the teachings of Hayashi and Ogata when properly considered in whole, still cannot render Claim 9 obvious

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for at least the reasons that they are not combinable, that there is no motivation to combine; and that even combined, they still cannot achieve the present invention as claimed. Therefore, Ogata and Hayashi, whether considered separately or combined together cannot render Claim 9 obvious.

For at least the same reasons discussed above, the methods of independent Claim 10 and 18 are also patentable over Hayashi and Ogata.

By the same token, dependent Claims 12 – 17 are also patentable for at least the same reasons (MPEP 2143.03).

Accordingly, withdrawal of this rejection is thus respectfully requested.

CONCLUSION

Applicant believes the foregoing amendments are responsive to all outstanding issues and places the present application in condition for allowance. Reexamination and reconsideration of the application are requested.

If for any reason the Examiner finds the application other than in condition for allowance, the Examiner is requested to call the undersigned attorney at the Los Angeles, California telephone number (310) 785-4600 to discuss the steps necessary for placing the application in condition for allowance.

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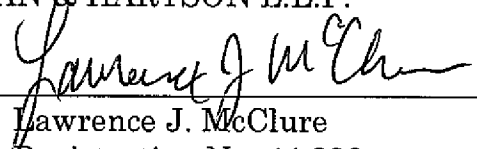
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Respectfully submitted,
HOGAN & HARTSON L.L.P.

Date: August 13, 2008

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